DIALOG(R)File 351:Derwent WPI

A6

011322274
WPI Acc No: 1997-300178/ 199728
XRAM Acc No: C97-097387
XRPX Acc No: N97-248029

Simplified die-casting apparatus for reducing gas defects - by confining the metal to one side of the plunger sleeve so the gases advance ahead of the molten metal

Patent Assignee: TOYOTA JIDOSHA KK (TOYT)
Inventor: MATSUURA Y; YAMASHITA Y
Number of Countries: 005 Number of Patents: 007
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
EP 778099	A2	19970611	EP 96119632	A	19961206	199728	B
JP 9155533	A	19970617	JP 95319042	A	19951207	199734	
US 5718280	A	19980217	US 96761825	A	19961206	199814	
KR 97033278	A	19970722	KR 9662403	A	19961206	199829	
KR 211756	B1	19990802	KR 9662403	A	19961206	200104	
EP 778099	B1	20011121	EP 96119632	A	19961206	200176	
DE 69617174	E	20020103	DE 617174	A	19961206	200210	
			EP 96119632	A	19961206		

Priority Applications (No Type Date): JP 95319042 A 19951207
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
EP 778099	A2	E	13	B22D-017/10	
Designated States (Regional): DE SE					
JP 9155533	A		7	B22D-017/30	
US 5718280	A		10	B22D-017/10	
KR 97033278	A			B22D-017/22	
KR 211756	B1			B22D-017/30	
EP 778099	B1	E		B22D-017/10	
Designated States (Regional): DE SE					
DE 69617174	E			B22D-017/10	Based on patent EP 778099

Abstract (Basic): EP 778099 A

A die-casting process comprises: (i) retracting a movable plunger chip (9) in a plunger sleeve connected to a mould cavity; (ii) supplying molten metal (14) to the plunger sleeve; (iii) localising it to one side of the plunger chip using an electromagnetic force generated by an electromagnetic induction coil (10); and (iv) advancing the retracted plunger chip to inject the localised molten metal into the mould cavity (3). Also claimed is a process using a contractible container to localise the molten metal in the plunger sleeve, the container being contracted when the plunger chip is advanced, injecting the metal into the mould. The apparatus for both processes is also claimed.

USE - This invention relates to a die-casting process, and the related apparatus, for injecting molten metal into a mould cavity, particularly to a method of separating evolved gases from the molten metal during casting.

ADVANTAGE - This invention provides a die-casting injection mechanism that inhibits injected molten metal from evolving gases contained in the plunger sleeve producing a die-cast product of high quality. This is achieved using a die-casting injection structure of simple construction, that can be easily incorporated into present die-casting machines.

Dwg.2/9

Abstract (Equivalent): US 5718280 A

A die-casting process comprises: (i) retracting a movable plunger

A6

chip (9) in a plunger sleeve connected to a mould cavity; (ii) supplying molten metal (14) to the plunger sleeve; (iii) localising it to one side of the plunger chip using an electromagnetic force generated by an electromagnetic induction coil (10); and (iv) advancing the retracted plunger chip to inject the localised molten metal into the mould cavity (3). Also claimed is a process using a contractible container to localise the molten metal in the plunger sleeve, the container being contracted when the plunger chip is advanced, injecting the metal into the mould. The apparatus for both processes is also claimed.

USE - This invention relates to a die-casting process, and the related apparatus, for injecting molten metal into a mould cavity, particularly to a method of separating evolved gases from the molten metal during casting.

ADVANTAGE - This invention provides a die-casting injection mechanism that inhibits injected molten metal from evolving gases contained in the plunger sleeve producing a die-cast product of high quality. This is achieved using a die-casting injection structure of simple construction, that can be easily incorporated into present die-casting machines.

Dwg.1/9

(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 778 099 B1

(12) EUROPEAN PATENT SPECIFICATION

(45) Date of publication and mention of the grant of the patent:
21.11.2001 Bulletin 2001/47

(51) Int Cl.[7]: **B22D 17/10**, B22D 17/30

(21) Application number: **96119632.6**

(22) Date of filing: **06.12.1996**

(54) **Die casting process and die casting apparatus**

Verfahren und Vorrichtung zum Druckgiessen

Procédé et dispositif pour la coulée sous pression

(84) Designated Contracting States:
DE SE

(30) Priority: **07.12.1995 JP 31904295**

(43) Date of publication of application:
11.06.1997 Bulletin 1997/24

(73) Proprietor: **TOYOTA JIDOSHA KABUSHIKI KAISHA**
Aichi-ken (JP)

(72) Inventors:
- **Matsuura, Yoshiki**
  Toyota-shi, Aichi-ken (JP)
- **Yamashita, Yasuhiro**
  Toyota-shi, Aichi-ken (JP)

(74) Representative: **Vollnhals, Aurel, Dipl.-Ing.**
Patentanwälte
Tiedtke-Bühling-Kinne & Partner
Bavariaring 4
80336 München (DE)

(56) References cited:
EP-A- 0 663 251 **FR-A- 628 463**
US-A- 3 211 286

- **DATABASE WPI Section Ch, Week 8137, Derwent Publications Ltd., London, GB; Class M22, AN 1981-67577D, XP002080029 & SU 791 449 A (NIKONOV S E) 30 December 1980**
- **PATENT ABSTRACTS OF JAPAN vol. 095, no. 010, 30 November 1995 & JP 07 178528 A (HITACHI METALS LTD), 18 July 1995**
- **PATENT ABSTRACTS OF JAPAN vol. 096, no. 003, 29 March 1996 & JP 07 299552 A (TSUOISU KK), 14 November 1995**

EP 0 778 099 B1

Description

[0001] The present invention relates to a die casting process according to the preambles of claim 1 and claim 8 as well as to a die casting apparatus according to the preamble of claim 14.

[0002] From the document US-A-3 211 286 a generic die casting apparatus is known in which the molten metal within the plunger sleeve is localized on a side of the retracted plunger tip, while the plunger tip is disposed in its retracted position. By moving the plunger tip in its advanced position the molten metal is injected into a cavity. Moreover, in order to supply molten metal into the compressible container of the die casting apparatus, the compressible container is removed from its retracted position. Basically the same analysis also applies to the die casting apparatuses known from the documents FR-A-628463 and SU-A-791449.

[0003] From the further cited documents EP-A-663251 and JP-A-07178528 die casting apparatuses are known which comprises an electromagnetic induction coil disposed around a plunger sleeve which is connected to a cavity of a mold.

[0004] In a die casting process for injecting a molten metal into a cavity of a mold at a fast rate, a molten metal is supplied into a plunger sleeve via a sprue, and a plunger chip is advanced to inject the supplied molten metal into a cavity of a clamped mold. The plunger chip is disposed movably in the plunger sleeve. In order to inhibit the molten metal from spilling at the sprue, a filling ratio of the plunger sleeve is usually designed to be from 30 to 70%. Accordingly, there exists air above the molten metal in the plunger sleeve. As a result, the molten metal shakes to involve the air therein. Thus, in the conventional die casting, the gas defects, such as gross porosities, or the like, are likely to occur. The term, "filling ratio", herein means the quotient (i.e., a volume V_0 of the molten metal divided by a volume V of the plunger sleeve) multiplied by 100.

[0005] JP 4-143,058 discloses a die casting apparatus which can inhibit the gas defects from occurring. The die casting apparatus is provided with two plunger sleeves and two plunger tips in order to increase the filling ratio in one of the plunger sleeves, thereby inhibiting the gas defects.

[0006] As illustrated in Figs. 8 and 9, in the die casting apparatus, a cavity 83 is formed between a stationary mold 81 and a movable mold 82 which are clamped together. A first plunger sleeve 84 has a sprue 84a, and is fitted into a sleeve-receiving hole of the stationary mold 81. The inside of the first plunger sleeve 84 is communicated with the cavity 83 by way of a runner 85 and a gate 86. The runner 85 is formed in the stationary mold 81. The gate 86 is formed in the movable mold 82, and is disposed above the runner 85. A second plunger sleeve 88 is fitted movably into the first plunger sleeve 84, and is connected to a hydraulic cylinder 87. Further, a first plunger tip 89 is fitted movably into the second plunger sleeve 88. Furthermore, a hydraulic cylinder 90 is fitted into the second plunger sleeve 88, and actuates the first plunger tip 89 to advance and retract. Moreover, the second plunger sleeve 88 is provided with a molten-metal inlet port 88a and a molten-metal outlet port 88b. The molten-metal inlet port 88a communicates with the sprue 84a of the first plunger sleeve 84 when the second plunger sleeve 88 is positioned at a retracted end. The molten-metal outlet port 88b communicates with the runner 85 when the second plunger sleeve 88 is positioned at an advanced end. In addition, a second plunger chip 91 is fixed at the leading end of the second plunger sleeve 88.

[0007] As illustrated in Fig. 8, in the die casting apparatus, the first plunger tip 89 and the second plunger chip 91 are retracted to supply a molten metal, and a molten metal is supplied into the second plunger sleeve 88 via the sprue 84a. Consequently, the sleeve-filling ratio can be 100% approximately in the second plunger sleeve 88. Then, the first plunger tip 89 and the second plunger chip 91 are advanced by actuating the hydraulic cylinder 87, and accordingly the molten metal can be transferred under the runner 85 while keeping the sleeve-filling ratio at about 100%. The situation is illustrated in Fig. 9. Thereafter, only the first plunger tip 89 is advanced by actuating the hydraulic cylinder 90, and thereby the molten metal, held in the second plunger sleeve 88, is injected into the cavity 83. As a result, when injecting the molten metal, the die casting apparatus can effectively inhibit the molten metal from involving the air.

[0008] However, the die casting apparatus disclosed in the publication has a complicated construction, because it requires two plunger sleeves and two plunger tips, and because it further requires two hydraulic cylinders to actuate one of the plunger sleeves and another one of the plunger tips, respectively. Further, when one intends to apply the die casting apparatus to existing die casting machines, or the like, the manufacturing facilities should be modified considerably. Furthermore, the second plunger sleeve 88 might not be operated properly, because the second plunger sleeve 88 slides in the first plunger sleeve 84. Specifically, the second plunger sleeve 88 might be subjected to enlarged sliding resistance which results from the thermal deformations of the first and second plunger sleeves 84 and 88, or might be seized by the molten metal which impregnates into the sliding clearance between the first and second plunger sleeves 84 and 88.

[0009] The present invention has been developed in view of the aforementioned circumstances. It is therefore an object of the present invention to provide a die casting process which can effectively inhibit a molten metal from involving a gas contained in a plunger sleeve when a molten metal is injected. Furthermore, a die casting apparatus shall be provided which can carry out the novel die casting process, and which has a simplified construction applicable to existing die casting machine with ease.

[0010] The above-stated object is achieved by the subject-matters of the independent claims 1, 8 and 14. Preferred embodiments of the these subject-matters are disclosed in the respective dependent claims.

[0011] In accordance with the die casting process according to a first aspect, and in accordance with the die casting apparatus according to a second aspect, the molten metal is supplied into the plunger sleeve, and is then localized on a side of the retracted plunger tip by means of the electromagnetic force induced by the electromagnetic induction coil. Under the circumstances, the retracted plunger tip is advanced. Accordingly, only gases, contained in the plunger sleeve, can be sent into the cavity of the mold at first, and thereafter the localized molten metal can be injected into the cavity. As a result, when the molten metal is injected, it is possible to effectively inhibit the molten metal from involving the gases.

[0012] In accordance with the another die casting process according to a third aspect, and in accordance with the another die casting apparatus according to a fourth aspect, the molten metal is supplied into and filled in the compressible container positioned at the retracted position. Along with the plunger tip, the compressible container filled with the supplied molten metal is advanced, and is compressed to inject the filled molten metal into the cavity of the mold. Accordingly, only gases, contained in the plunger sleeve, can be sent into the cavity of the mold at first, and thereafter the filled molten metal can be injected into the cavity. As a result, when the molten metal is injected, it is possible to effectively inhibit the molten metal from involving the gases. Moreover, the molten metal can be kept from directly contacting with the plunger sleeve, because the compressible container interposes between the molten metal and the plunger sleeve. Thus, it is possible to inhibit the molten metal from damaging the plunger sleeve.

[0013] As having described so far, the die casting processes and the die casting apparatuses according to the present invention employ the simplified constructions, for instance, the electromagnetic induction coil disposed around the plunger sleeve, and the compressible container disposed movably in the plunger cylinder. The simplified constructions enable the molten metal, supplied in the plunger sleeve, to localize on the side of the plunger tip, and also enable the localized molten metal to spout into the cavity. As a result, the simplified constructions can inhibit the molten metal from involving the gases, such as air, or the like, and accordingly can produce high-quality cast products which little involve the gas defects.

[0014] In the following, embodiments of the invention are described in detail with reference to the accompanying drawings.

Fig. 1 is a cross-sectional view of a die casting apparatus according to a First Preferred Embodiment of the present invention, and illustrates how a molten metal is supplied;

Fig. 2 is a cross-sectional view of the present die casting apparatus according to the First Preferred Embodiment, and illustrates how the molten metal, supplied in a plunger sleeve, is localized on a side of a plunger tip;

Fig. 3 is a cross-sectional view of the present die casting apparatus according to the First Preferred Embodiment, and illustrates a state after the localized molten metal is injected;

Fig. 4 is a perspective view of an electromagnetic induction coil assembly (designated at 10) in the present die casting apparatus according to the First Preferred Embodiment, and illustrates partly in cross-section how the electromagnetic induction coil assembly is constructed;

Fig. 5 is a cross-sectional view of a die casting apparatus according to a Second Preferred Embodiment of the present invention, and illustrates how a molten metal is supplied;

Fig. 6 is a cross-sectional view of the present die casting apparatus according to the Second Preferred Embodiment, and illustrates a state after the supplied molten metal is injected;

Fig. 7 is a perspective view of a molten metal pack (or a compressible container) in the present die casting apparatus according to the Second Preferred Embodiment, and illustrates a configuration of the molten metal pack schematically;

Fig. 8 is a cross-sectional view of a conventional die casting apparatus, and illustrates how a molten metal is supplied; and

Fig. 9 is a cross-sectional view of the conventional die casting apparatus, and illustrates a state immediately before the supplied molten metal is injected into a cavity.

First Preferred Embodiment

[0015] Figs. 1 through 4 illustrate a First Preferred Embodiment of the present invention. The First Preferred Embodiment is an application of the die casting process according to a first aspect of the present invention and the die casting apparatus according to a second aspect of the present invention to aluminium-alloy die casting.

[0016] A die casting apparatus according to the present invention will be first described in terms of the construction. The die casting apparatus includes a stationary plate 1, a stationary mold 1a, a movable plate 2, and a movable mold 2a. The stationary mold 1a is installed to the stationary plate 1. The movable mold 2a is installed to the movable plate 2, and is advanced to and retracted from the stationary mold 1a to close and open an entire mold. When the entire mold is closed, there is formed a cavity 3 between the stationary mold 1a and the movable mold 2a. The stationary plate 1 and the stationary mold 1a are provided with a plunger-sleeve-receiving hole into which a plunger sleeve 4 is

fitted. The plunger sleeve 4 is made from either ceramics or metal, and is provided with a sprue 4a. The inner space of the plunger sleeve 4 is communicated with the cavity 3 by way of a runner 5 and a gate 6. The runner 5 is formed in the stationary mold 1a. The gate 6 is formed in the movable mold 2a, and is disposed above the runner 5. A plunger tip 9 is fitted movably into the plunger sleeve 4. The plunger tip 9 is made from either ceramics or metal, and is connected to a rod 8 of an injection cylinder 7.

[0017] Moreover, as illustrated in Figs. 1 through 3, the plunger sleeve 4 is projected from the stationary plate 1. On an outer peripheral surface of the projecting plunger sleeve 4, an electromagnetic induction coil assembly 10 is disposed adjacent to the stationary plate 1. As illustrated in Fig. 4, the electromagnetic induction coil assembly 10 includes a plurality of rectangle-shaped metallic radiation plates 11, and a plurality of induction coils 12. The metallic radiation plates 11 stick out from the outer peripheral surface of the plunger sleeve 4 radially, and their major-width sides run parallel to the axial direction of the plunger sleeve 4. The induction coils 12 are wound around the outer peripheral surface of the plunger sleeve 4 through the metallic radiation plates 11 and the spaces interposing the metallic radiation plates 11, and receive a supply of a predetermined electric current from an electric-current source (not shown). As a result of the electric-current supply to the induction coils 12, an electromagnetic force is generated in accordance with the Fleming's left-hand rule. Hence, the magnitude and direction of the electric current supplied to the induction coils 12, and the number of turns in the induction coils 12 can be appropriately determined so that the generated electromagnetic force can satisfactorily localize a molten metal, supplied into the plunger sleeve 4, on the side of plunger tip 9. For example, the frequency of the supplied electric current can be about 10 Hz, and the number of turns in the induction coils 12 can be 20 turns.

[0018] The thus constructed die casting apparatus is operated in the following manner: as illustrated in Fig. 1, the plunger tip 9 is retraced behind the sprue 4a by actuating the injection cylinder 7. With the plunger tip 9 thus retracted, a molten metal 14 is supplied into the plunger sleeve 4 from a ladle 13 via the sprue 4a. The supplying amount of the molten metal 14 is not limited in particular. Note that, however, the supplying amount can be designed to be an ordinary sleeve-filling ratio (e.g., from 30 to 70%). Then, the plunger tip 9 is advanced slightly by actuating the injection cylinder 7 to close the sprue 4a. With the sprue 4a thus closed, a predetermined electric current is input into the electromagnetic induction coils 12 of the electromagnetic induction coil assembly 10 to let the electromagnetic induction coils 12 generate an electromagnetic force. Accordingly, as illustrated in Fig. 2, the molten metal 14, supplied into the plunger sleeve 4, is moved to and localized on the side of the plunger tip 9 by the thus generated electromagnetic force. Consequently, only gases, such as air, or the like, are present in the plunger sleeve 4 on the side of the cavity 3. On the other hand, in the plunger sleeve 4 on the side of the plunger tip 9, a cross-sectional-area occupying ratio of the molten metal 14 can be virtually 100%. Thereafter, as illustrated in Fig. 3, the plunger tip 9 is further advanced by actuating the injection cylinder 7. Note that the electromagnetic force can be kept induced by the electromagnetic induction coil assembly 10 when the plunger chip 9 is further advanced. Thus, only the gases, such as air, or the like, can be first transferred into the cavity 3 by way of the runner 5 and the gate 6, and subsequently the molten metal 14 can be injected into the cavity 3 while keeping the cross-sectional-area occupying ratio substantially at 100% approximately. As a result, when injecting the molten metal 14, it is possible to effectively inhibit the molten metal 14 from involving the gases which have existed in the plunger sleeve 4. All in all, it is possible to produce high-quality cast products which little involve the gas defects. Note that the term, "cross-sectional-area occupying ratio", herein means the quotient (i.e., a cross-sectional area of the molten metal 14 divided by a cross-sectional area of the plunger sleeve 4) multiplied by 100.

[0019] The die casting apparatus according to the First Preferred Embodiment can be applied to existing die casting machines with ease, because it employs the simplified construction: namely; the electromagnetic induction coil assembly 10 disposed on the outer peripheral surface of the plunger sleeve 4. Moreover, the conventional die casting apparatus is provided with two plunger sleeves, etc., and accordingly might be operated improperly by the molten-metal seizure. Contrary to the conventional die casting apparatus, the die casting apparatus according to the First Preferred Embodiment will not suffer from the drawback, because it employs the single independent plunger sleeve 4.

Second Preferred Embodiment

[0020] Figs. 5 through 7 illustrate a Second Preferred Embodiment of the present invention. Except that a molten-metal pack 20 is employed, a die casting apparatus according to the Second Preferred Embodiment has basically the same construction as that of the die casting apparatus according to the First Preferred Embodiment.

[0021] Specifically, in the die casting apparatus according to the Second Preferred Embodiment, a molten-metal pack 20 is disposed movably in a plunger sleeve 4. Note that the molten-metal pack 20 works as the compressible container according to a third and fourth aspect of the present invention. The molten-metal pack 20 is made from pure aluminium. As illustrated in Fig. 7, the molten-metal pack 20 includes a cylinder-shaped member 21, and a pair of disks 22, 22. The cylinder-shaped member 21 has an opening 21a facing upwardly. The upwardly-facing opening 21a is prepared by removing

the upper leading-end portion of a cylinder-shaped workpiece and by leaving the trailing-end portion thereof by a minute margin. The disks 22, 22 enclose the opposite ends of the cylinder-shaped member 21. Note that the outside diameter of the cylinder-shaped member 21 and the disks 22, 22 is designed to be substantially identical with the inside diameter of the plunger sleeve 4.

[0022] The thickness of the cylinder-shaped member 21 and the disks 22, 22 is not limited in particular. However, the thickness can preferably fall in a range of from 0.1 to 0.5 mm approximately. In the Second Preferred Embodiment, both of the cylinder-shaped member 21 and the disks 22, 22 are designed to have a thickness of 0.3 mm. In addition to the pure aluminium, the molten-metal pack 20 can be made from a material which is compressible and which has a melting point higher than a temperature of the employed molten metal 14. Moreover, the configuration and size of the molten-metal pack 20 are not limited in particular, either. However, in order to enlarge the cross-sectional-area occupying ratio of the molten metal 14 as much as possible, the molten-metal pack 20 can preferably be designed to have the same configuration and the same size as those of the inner peripheral surface of the plunger sleeve 4.

[0023] In the Second Preferred Embodiment, the molten-metal pack 20 is taken out together with an as-cast product. Therefore, it is necessary to set the molten-metal pack 20 in the plunger sleeve 4 for every casting operation. The setting of the molten-metal pack 20 can be carried out in the following manner: the plunger tip 9 is removed from the plunger sleeve 4. The molten-metal pack 20 is fitted into the plunger sleeve 4 by way of the opposite opening 4b which is disposed furthest away from the runner 5, and is placed at a predetermined position in the plunger sleeve 4. Thereafter, the plunger tip 9 is again fitted into the plunger sleeve 4 by way of the opposite opening 4b.

[0024] The thus constructed die casting apparatus is operated in the following manner: as illustrated in Fig. 5, the molten-metal pack 20 is positioned so that one of the opposite ends (e.g., the opposite end furthest away from the runner 5) of the upwardly-facing opening 21a is placed below the sprue 4a of the plunger sleeve 4, and the plunger tip 9 is positioned on the rear side of the molten-metal pack 20. Then, the molten metal 14 is supplied into the plunger sleeve 4 from the ladle 13 via the sprue 4a. Note that the molten metal 14 is supplied into the molten-metal pack 20 so that the cross-sectional-area occupying ratio of the molten metal 14 is virtually 100% in the molten-metal pack 20. Thereafter, as illustrated in Fig. 6, the molten-metal pack 20 is advanced along with the plunger chip 9 by actuating the injection cylinder 7, and the molten-metal pack 20 is held and pressurized between the end surface of the movable mold 2a and the plunger tip 9. As a result, the molten-metal pack 20 is compressed to deform, and accordingly the molten metal 14 filled in the molten-metal pack 20 can be injected into the cavity 3.

[0025] In a manner similar to the First Preferred Embodiment, in the Second Preferred Embodiment as well, only the gases, such as air, or the like, can be first transferred into the cavity 3 by way of the runner 5 and the gate 6, and subsequently the molten metal 14 can be injected into the cavity 3 while keeping the cross-sectional-area occupying ratio substantially at 100% approximately. Note that the gases have been present in the plunger sleeve 4. As a result, when injecting the molten metal 14, it is possible to effectively inhibit the molten metal 14 from involving the gases which have existed in the plunger sleeve 4. All in all, it is possible to produce high-quality cast products which little involve the gas defects.

[0026] The die casting apparatus according to the Second Preferred Embodiment can inhibit cast products from involving the gas defects with extreme readiness, and at a remarkably low cost, because it simply employs the molten-metal pack 20, and because it does not require electric facilities in addition to the molten-metal pack 20. Moreover, the molten-metal seizure is less likely to occur between the molten-metal pack 20 and the plunger sleeve 4, because the molten-metal pack 20 is reset for every casting operation.

[0027] In the First and Second Preferred Embodiments, a sprue bushing can substitute for the portion of the plunger sleeve 4 adjacent to the runner 5.

[0028] In addition, the First and Second Preferred Embodiments describe how to apply the present invention to aluminium-alloy casting. The present invention can be applied, of course, to casting for the other metals, such as cast iron, etc.

[0029] Having now fully described the present invention, it will be apparent to one of ordinary skill in the art that many changes and modifications can be made thereto without departing from the spirit or scope of the present invention as set forth herein including the appended claims.

[0030] A die casting process, and a die casting apparatus make it possible to produce high-quality cast products, which little involve gas defects, with simplified constructions, such as an electromagnetic induction coil disposed around a plunger sleeve, and a contractible container disposed movably in a plunger sleeve. With these simplified constructions, a molten metal is localized on a side of a retracted plunger tip disposed in the plunger sleeve. Accordingly, when the retracted plunger tip is advanced, only gases, contained in the plunger sleeve, can be transferred to a cavity of a mold at first, and thereafter the localized molten metal can be injected into the cavity. Thus, it is possible to effectively inhibit the molten metal from involving the gases.

Claims

1. A die casting process, comprising the steps of:

retracting a plunger tip (9) disposed movable in a plunger sleeve (4) connected to a cavity (3) of a mold (1a, 2a):
supplying a molten metal (14) into the plunger sleeve (4) with the retracted plunger tip (9) disposed therein;
localizing the supplied molten metal (14) on a side of the retracted plunger tip; and
advancing the retracted plunger tip to inject the localized molten metal into the cavity, **characterized in that** the supplied molten metal (14) is localized by means of an electromagnetic force induced by an electromagnetic induction coil (10).

2. The die casting process according to Claim 1, wherein, in said molten-metal supplying step, the molten metal occupies the plunger sleeve (4) with a cross-sectional-area occupying ratio from 30 to 70%.

3. The die casting process according to Claim 1, wherein, in said supplied-molten-metal localizing step, the molten metal occupies the side of the retracted plunger tip (9) in the plunger sleeve (4) with a cross-sectional-area occupying ratio of 100% virtually.

4. The die casting process according to Claim 1, wherein, in said supplied-molten-metal localizing step, the electromagnetic force is induced by the electromagnetic induction coil (10) which is disposed on a side of the mold (1a, 2a).

5. The die casting process according to Claim 1, wherein, in said retracted-plunger-tip advancing step, the molten metal occupies the side of the retracted plunger tip (9) in the plunger sleeve (4) with a cross-sectional-area occupying ratio of 100% virtually.

6. The die casting process according to Claim 1, wherein, in said retracted-plunger-tip advancing step, gases contained in the plunger sleeve (4) are transferred into the cavity (3) at first.

7. The die casting process according to Claim 1, wherein, in said retracted-plunger-tip advancing step, the electromagnetic force is kept induced by the electromagnetic induction coil (10).

8. A die casting process, comprising the steps of:

retracting a plunger tip (9) disposed movably in a plunger sleeve (4) connected to a cavity (3) of a mold (1a, 2a):
supplying a molten metal (14) into a compressible container (20) which is disposed on the retracted plunger tip and which is movably from a retracted position to an advanced position in the plunger sleeve (4); and
advancing the compressible container (20) filled with the supplied molten metal (14) by advancing the retracted plunger tip (9), and compressing the compressible container (20) to inject the filled molten metal (14) into the cavity (3), **characterized in that,** while the molten metal is supplied into the compressible container, the compressible container is positioned at the retracted position.

9. The die casting process according to the Claim 8, wherein, in said molten-metal supplying step, the molten metal occupies the compressible container with a cross-sectional-area occupying ratio of 100% virtually.

10. The die casting process according to Claim 8, wherein, in said molten-metal supplying step, gases contained in the plunger sleeve (4) occupy a side of the mold (1a, 2a) in the plunger sleeve (4) with a cross-sectional-area occupying ratio of 100% virtually.

11. The die casting process according to Claim 8, wherein, in said compressible-container advancing step, gases contained in the plunger sleeve (4) are transferred into the cavity (3) at first.

12. The die casting process according to Claim 8, wherein, in said compressible-container advancing step, the compressible container (20) filled with the supplied molten metal is compressed between the mold (1a, 2a) and the plunger tip (9), thereby injecting the filled molten metal into the cavity (3).

13. The die casting process according to Claim 8, wherein, after said compressible-container advancing step, the compressed compressible container (20) is removed from the plunger sleeve (4), and is replaced with a new compressible container (20) for every die casting operation.

14. A die casting apparatus, comprising:

a plunger sleeve (4) connected to a cavity (3) of a mold (1a, 2a), and receiving a supply of a molten metal (14);
a plunger tip (9) disposed movably in said plunger sleeve (4), and injecting the supplied molten metal (14) into the cavity (3); and said diecasting apparatus comprising in use
a compressible container (20) disposed movably in said plunger sleeve (4), and holding the supplied molten metal (14) therein, **characterized in that** said compressible container in-

cludes an opening (21a) facing upwardly, the upwardly-facing opening being prepared by removing a predetermined length of a leading-end portion at a top of said container and by leaving a predetermined margin of a trailing-end portion of said container.

15. The die casting apparatus according to Claim 14, wherein said compressible container (20) is made from a material which is compressible, and which has a melting point higher than a temperature of the molten metal.

16. The die casting apparatus according to Claim 14, wherein the die casting apparatus is for aluminium-alloy die casting, and said compressible container (20) is made from pure aluminium.

17. The die casting apparatus according to Claim 14, wherein said compressible container (20) is formed of a cylinder-shaped member having a leading-end opening, a leading-end portion, a trailing-end portion and a trailing-end opening; and a pair of disks (22) enclosing the leading-end opening and the trailing-end opening of the cylinder-shaped member.

18. The die casting apparatus according to Claim 17, wherein the cylinder-shaped member and disks (22) of said compressible container (20) have an outside diameter which is substantially identical with an inside diameter of said plunger sleeve (4).

19. The die casting apparatus according to Claim 14, wherein said compressible container (20) has a thickness falling in a range of from 0.1 to 0.5 mm.

20. The die casting apparatus according to Claim 14, wherein said compressible container (20) has a configuration and a size which are identical with those of an inner peripheral surface of said plunger sleeve (4).

Patentansprüche

1. Druckgießprozess mit folgenden Schritten:

   Zurückziehen einer Druckkolbenspitze (9), die in einer mit einem Hohlraum (3) einer Gießform (1a, 2a) verbundenen Druckkolbenbuchse (4) bewegbar angeordnet ist;
   Zuführen eines geschmolzenen Metalls (14) in die Druckkolbenbuchse (4), wobei die zurückgezogene Druckkolbenspitze (9) darin angeordnet ist;
   Anordnen des zugeführten geschmolzenen Metalls (14) an einer Seite der zurückgezogenen Druckkolbenspitze; und
   Vorrücken der zurückgezogenen Druckkolbenspitze, um das angeordnete geschmolzene Metall in den Hohlraum einzuspritzen,

   dadurch gekennzeichnet, dass
   das zugeführte geschmolzene Metall (14) mittels einer durch eine Elektromagnetinduktionsspule (10) induzierten elektromagnetischen Kraft angeordnet wird.

2. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Zuführen des geschmolzenen Metalls das geschmolzene Metall die Druckkolbenbuchse (4) mit einem Querschnittsflächenabdeckungsverhältnis von 30 bis 70% abdeckt.

3. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Anordnen des zugeführten geschmolzenen Metalls das geschmolzene Metall die Seite der zurückgezogenen Druckkolbenspitze (9) in der Druckkolbenbuchse (4) mit einem Querschnittsflächenabdeckungsverhältnis von nahezu 100% abdeckt.

4. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Anordnen des zugeführten geschmolzenen Metalls die elektromagnetische Kraft durch die Elektromagnetinduktionsspule 10 induziert wird, die an einer Seite der Gießform (1a, 2a) angeordnet ist.

5. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Vorrücken der zurückgezogenen Druckkolbenspitze das geschmolzene Metall die Seite der zurückgezogenen Druckkolbenspitze (9) in der Druckkolbenbuchse (4) mit einem Querschnittsflächenabdeckungsverhältnis von nahezu 100% abdeckt.

6. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Vorrücken der zurückgezogenen Druckkolbenspitze zunächst in der Druckkolbenbuchse (4) enthaltene Gase in den Hohlraum (3) befördert werden.

7. Druckgießprozess gemäß Anspruch 1, wobei bei dem Schritt zum Vorrücken der zurückgezogenen Druckkolbenspitze die elektromagnetische Kraft weiterhin durch die Elektromagnetinduktionsspule (10) induziert wird.

8. Druckgießprozess mit folgenden Schritten:

   Zurückziehen einer Druckkolbenspitze (9), die in einer mit einem Hohlraum (3) einer Gießform (1a, 2a) verbundenen Druckkolbenbuchse (4) bewegbar angeordnet ist;

Zuführen eines geschmolzenen Metalls (14) in einen komprimierbaren Behälter (20), der an der zurückgezogenen Druckkolbenspitze angeordnet ist und der von einer zurückgezogenen Position zu einer vorgerückten Position in der Druckkolbenbuchse (4) bewegbar ist; und Vorrücken des mit dem zugeführten geschmolzenen Metall (14) gefüllten komprimierbaren Behälters (20), indem die zurückgezogene Druckkolbenspitze (9) vorgerückt wird, und Komprimieren des komprimierbaren Behälters (20), um das eingefüllte geschmolzene Metall (14) in den Hohlraum (3) einzuspritzen,

dadurch gekennzeichnet, dass der komprimierbare Behälter an der zurückgezogenen Position angeordnet ist, während das geschmolzene Metall dem komprimierbaren Behälter zugeführt wird.

9. Druckgießprozess gemäß Anspruch 8, wobei bei dem Schritt zum Zuführen des geschmolzenen Metalls das geschmolzene Metall den komprimierbaren Behälter mit einem Querschnittsflächenabdeckungsverhältnis von nahezu 100% abdeckt.

10. Druckgießprozess gemäß Anspruch 8, wobei bei dem Schritt zum Zuführen des geschmolzenen Metalls die in der Druckkolbenbuchse (4) enthaltenen Gase eine Seite der Gießform (1a, 2a) in der Druckkolbenbuchse (4) mit einem Querschnittsflächenabdeckungsverhältnis von nahezu 100% abdecken.

11. Druckgießprozess gemäß Anspruch 8, wobei bei dem Schritt zum Vorrücken des komprimierbaren Behälters zunächst die in der Druckkolbenbuchse (4) enthaltenen Gase in den Hohlraum (3) befördert werden.

12. Druckgießprozess gemäß Anspruch 8, wobei bei dem Schritt zum Vorrücken des komprimierbaren Behälters der mit dem zugeführten geschmolzenen Metall gefüllte komprimierbare Behälter (20) zwischen der Gießform (1a, 2a) und der Druckkolbenspitze (9) komprimiert wird, um dadurch das eingefüllte geschmolzene Metall in den Hohlraum (3) einzuspritzen.

13. Druckgießprozess gemäß Anspruch 8, wobei nach dem Schritt zum Vorrücken des komprimierbaren Behälters der komprimierte komprimierbare Behälter (20) aus der Druckkolbenbuchse (4) entfernt wird und für jeden Druckgießvorgang durch einen neuen komprimierbaren Behälter (20) ausgetauscht wird.

14. Druckgießvorrichtung mit:

einer Druckkolbenbuchse (4), die mit einem Hohlraum (3) einer Gießform (1a, 2a) verbunden ist und eine Zufuhr eines geschmolzenen Metalls (14) aufnimmt;
einer Druckkolbenspitze (9), die in der Druckkolbenbuchse (4) bewegbar angeordnet ist und das zugeführte geschmolzene Metall (14) in den Hohlraum (3) einspritzt; und
die Druckgießvorrichtung weist beim Gebrauch einen komprimierbaren Behälter (20) auf, der in der Druckkolbenbuchse (4) bewegbar angeordnet ist und das zugeführte geschmolzene Metall (14) darin hält,

dadurch gekennzeichnet, dass der komprimierbare Behälter eine nach oben gerichtete Öffnung (21a) hat, wobei die nach oben gerichtete Öffnung so ausgebildet ist, dass eine vorbestimmte Länge eines vorderen Endabschnitts eines oberen Abschnitts des Behälters entfernt ist und dass ein vorbestimmter Rand eines hinteren Endabschnitts des Behälters übrig ist.

15. Druckgießvorrichtung gemäß Anspruch 14, wobei der komprimierbare Behälter (20) aus einem Material geschaffen ist, das komprimierbar ist und einen höheren Schmelzpunkt als eine Temperatur des geschmolzenen Metalls hat.

16. Druckgießvorrichtung gemäß Anspruch 14, wobei die Druckgießvorrichtung zum Druckgießen einer Aluminiumlegierung vorgesehen ist und der komprimierbare Behälter (20) aus reinem Aluminium geschaffen ist.

17. Druckgießvorrichtung gemäß Anspruch 14, wobei der komprimierbare Behälter (20) aus einem zylinderförmigen Element mit einer Öffnung am vorderen Ende, einem vorderen Endabschnitt, einem hinteren Endabschnitt und einer Öffnung am hinteren Ende sowie einem Paar Scheiben (22) ausgebildet ist, die die Öffnung am vorderen Ende und die Öffnung am hinteren Ende des zylinderförmigen Elements abschließen.

18. Druckgießvorrichtung gemäß Anspruch 17, wobei das zylinderförmige Element und die Scheiben (22) des komprimierbaren Behälters (20) einen äußeren Durchmesser haben, der im Wesentlichen gleich ist wie ein innerer Durchmesser der Druckkolbenbuchse (4).

19. Druckgießvorrichtung gemäß Anspruch 14, wobei der komprimierbare Behälter (20) eine Dicke hat, die in einen Bereich von 0,1 bis 0,5 mm fällt.

20. Druckgießvorrichtung gemäß Anspruch 14, wobei der komprimierbare Behälter (20) einen Aufbau und

eine Größe hat. die identisch mit jenen einer inneren Umfangsfläche der Druckkolbenbuchse (4) sind.

Revendications

1. Procédé de moulage sous pression, comportant les étapes consistant à :

   - rétracter une tige de plongeur (9) disposée mobile dans un manchon de plongeur (4) relié à une cavité (3) d'un moule (1a, 2a) ;
   - apporter un métal fondu (14) dans le manchon de plongeur (4), la tige de plongeur rétractée étant disposée dans le manchon ;
   - mettre en place le métal fondu apporté (14) sur une face de la tige de plongeur rétractée ; et
   - faire avancer la tige de plongeur rétractée pour injecter le métal fondu mis en place dans la cavité,

   caractérisé en ce que le métal fondu apporté (14) est mis en place au moyen d'une force électromagnétique induite par une bobine d'induction électromagnétique (10).

2. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans ladite étape d'apport de métal fondu, le métal fondu occupe le manchon de plongeur (4) selon un rapport d'occupation de la superficie de la section situé entre 30 et 70 %.

3. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans ladite étape de mise en place du métal fondu apporté, le métal fondu occupe la face de la tige de plongeur rétractée (9) dans le manchon de plongeur (4) selon un rapport d'occupation de la superficie de la section de 100 % en pratique.

4. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans ladite étape de mise en place du métal fondu apporté, la force électromagnétique est induite par la bobine d'induction électromagnétique (10) qui est disposée sur un côté du moule (1a. 2a).

5. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans l'étape consistant à faire avancer ladite tige de plongeur rétractée, le métal fondu occupe la face de la tige de plongeur rétractée (9) dans le manchon de plongeur (4) selon un rapport d'occupation de la superficie de la section de 100 % en pratique.

6. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans l'étape consistant à faire avancer ladite tige de plongeur rétractée, les gaz contenus dans le manchon de plongeur (4) sont transférés en premier dans la cavité (3).

7. Procédé de moulage sous pression selon la revendication 1, dans lequel, dans l'étape consistant à faire avancer ladite tige de plongeur rétractée, la force électromagnétique induite par la bobine d'induction électromagnétique est maintenue.

8. Procédé de moulage sous pression, comportant les étapes consistant à :

   - rétracter une tige de plongeur (9) disposée mobile dans un manchon de plongeur (4) relié à une cavité (3) d'un moule (1a, 2a) ;
   - apporter un métal fondu (14) dans un récipient compressible (20) qui est disposé sur la tige de plongeur rétractée et qui peut se déplacer d'une position rétractée à une position avancée dans le manchon de plongeur (4) ; et
   - faire avancer le récipient compressible (20) rempli du métal fondu apporté (14) en faisant avancer la tige de plongeur rétractée (9), et comprimer le récipient compressible (20) en vue d'injecter le métal fondu apporté (14) dans la cavité (3),

   caractérisé en ce que, pendant que le métal fondu est apporté dans le récipient compressible, le récipient compressible est positionné en position rétractée.

9. Procédé de moulage sous pression selon la revendication 8, dans lequel, dans ladite étape consistant à apporter le métal fondu, le métal fondu occupe le récipient compressible selon un rapport d'occupation de la superficie de la section de 100 % en pratique.

10. Procédé de moulage sous pression selon la revendication 8, dans lequel, dans ladite étape consistant à apporter le métal fondu, les gaz contenus dans le manchon de plongeur (4) occupent un côté du moule (1a, 2a) dans le manchon de plongeur (4) selon un rapport d'occupation de la superficie de la section de 100 % en pratique.

11. Procédé de moulage sous pression selon la revendication 8, dans lequel, dans ladite étape consistant à faire avancer le récipient compressible, les gaz contenus dans le manchon de plongeur (4) sont transférés en premier dans la cavité (3).

12. Procédé de moulage sous pression selon la revendication 8, dans lequel, dans ladite étape consistant à faire avancer le récipient compressible, le récipient compressible (20) rempli du métal fondu ap-

porté est comprimé entre le moule (1a, 2a) et la tige de plongeur (9), ce qui provoque l'injection du métal fondu apporté dans la cavité (3).

13. Procédé de moulage sous pression selon la revendication 8, dans lequel, après ladite étape consistant à faire avancer le récipient compressible, le récipient compressible comprimé (20) est extrait du manchon de plongeur (4) et est remplacé par un nouveau récipient compressible (20) en vue de chaque opération de moulage sous pression.

14. Appareil de moulage sous pression, comprenant :

- un manchon de plongeur (4) relié à une cavité (3) d'un moule (1a, 2a) et recevant un apport en métal fondu (14) ;
- une tige de plongeur (9) disposée mobile dans ledit manchon de plongeur (4) et injectant le métal fondu apporté (14) dans la cavité (3) ; et ledit appareil de moulage sous pression comprenant pendant l'usage un récipient compressible (20) disposé mobile dans ledit manchon de plongeur (4) et contenant le métal fondu apporté (14),

caractérisé en ce que ledit récipient compressible comporte une ouverture (21a) orientée vers le haut, l'ouverture orientée vers le haut étant réalisée en enlevant une longueur prédéterminée d'une portion d'extrémité avant dans le haut dudit récipient et en laissant une marge prédéterminée d'une portion d'extrémité arrière dudit récipient.

15. Appareil de moulage sous pression selon la revendication 14, dans lequel ledit récipient compressible (20) est réalisé en un matériau compressible et qui présente un point de fusion supérieur à la température du métal fondu.

16. Appareil de moulage sous pression selon la revendication 14, dans lequel l'appareil de moulage sous pression est destiné au moulage sous pression d'un alliage d'aluminium et ledit récipient compressible (20) est réalisé en aluminium pur.

17. Appareil de moulage sous pression selon la revendication 14, dans lequel ledit récipient compressible (20) est formé d'un élément en forme de cylindre présentant une ouverture à son extrémité avant, une portion d'extrémité avant, une portion d'extrémité arrière et une ouverture à son extrémité arrière ; et une paire de disques (22) fermant l'ouverture d'extrémité avant et l'ouverture d'extrémité arrière de l'élément en forme de cylindre.

18. Appareil de moulage sous pression selon la revendication 17, dans lequel l'élément en forme de cylindre et les disques (22) dudit récipient compressible (20) présentent un diamètre externe qui est sensiblement identique au diamètre interne dudit manchon de plongeur (4).

19. Appareil de moulage sous pression selon la revendication 14, dans lequel ledit récipient compressible (20) a une épaisseur située dans la plage allant de 0,1 à 0,5 mm.

20. Appareil de moulage sous pression selon la revendication 14, dans lequel ledit récipient compressible (20) présente une configuration et une taille qui sont identiques à celles de la surface périphérique interne dudit manchon de plongeur (4).

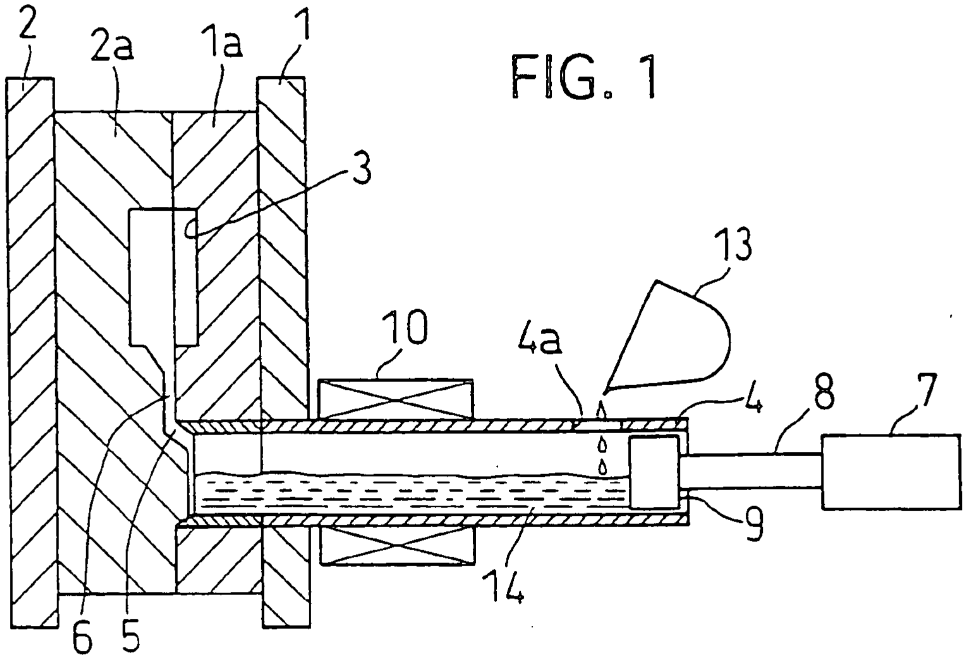


FIG. 1

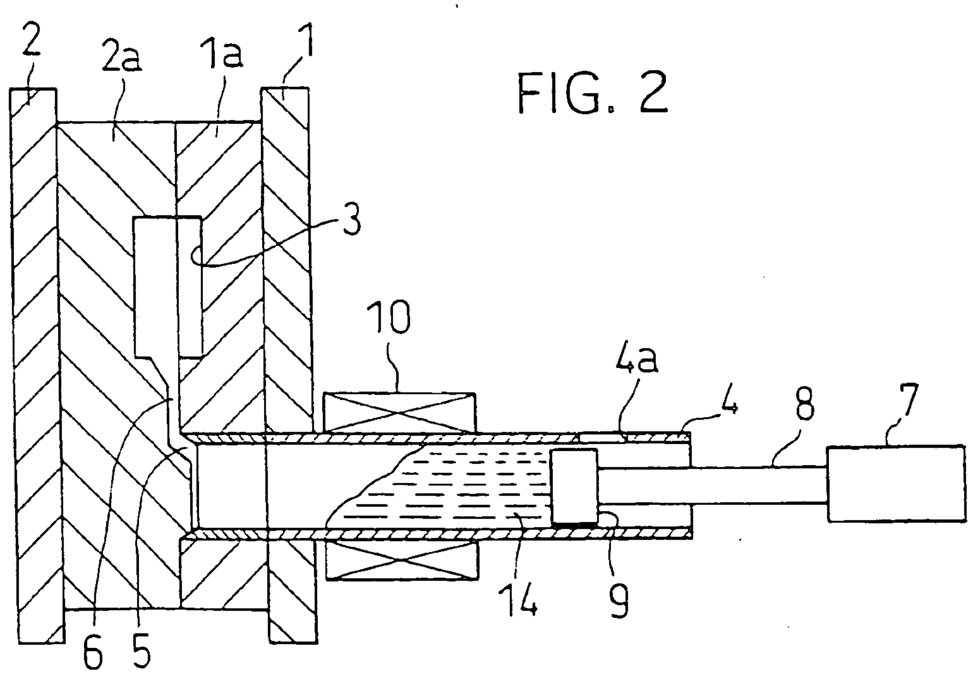


FIG. 2

FIG. 3

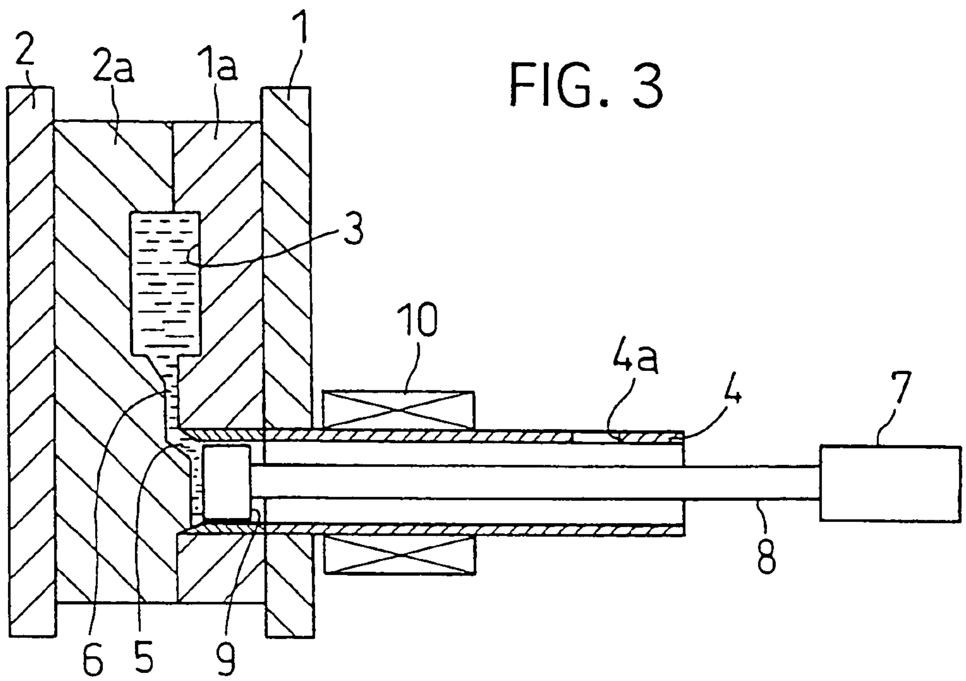


FIG. 4

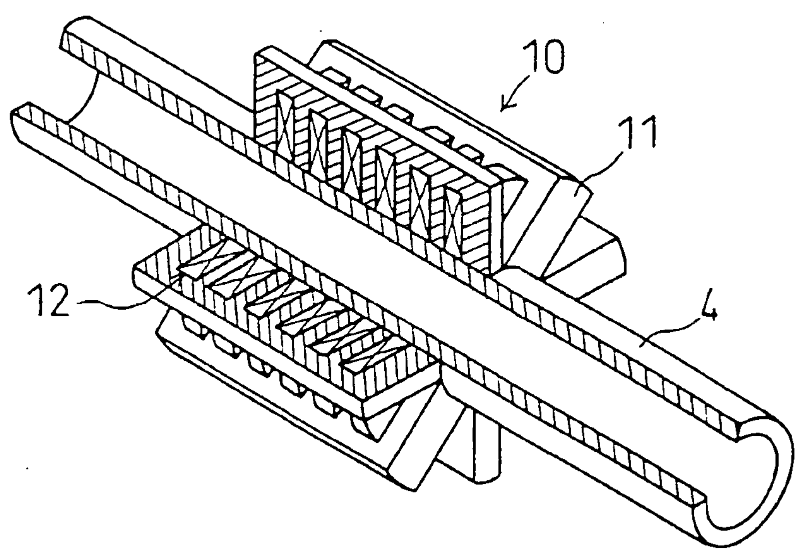


FIG. 5

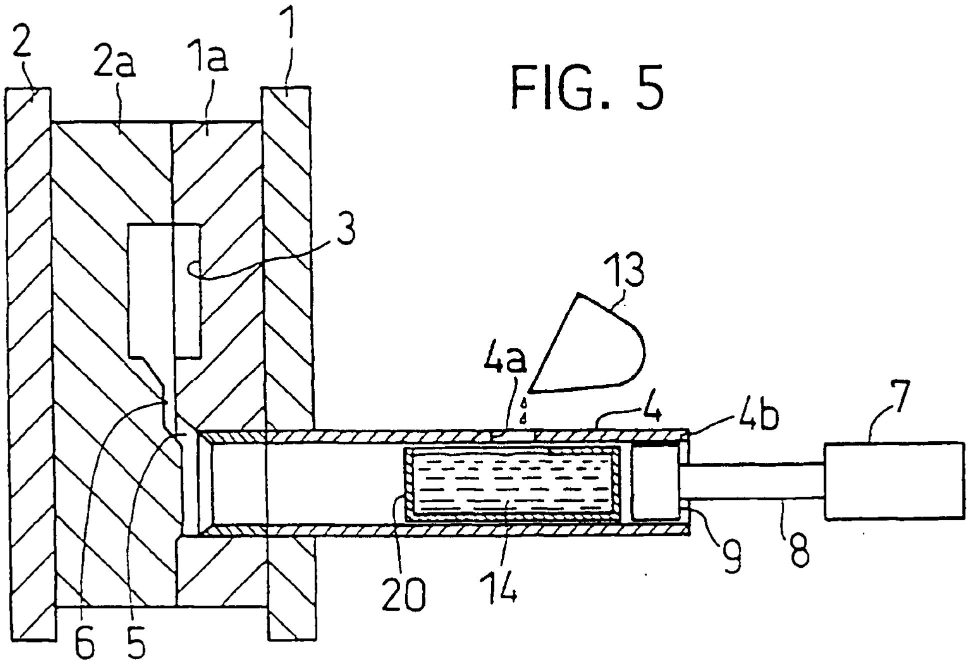


FIG. 6

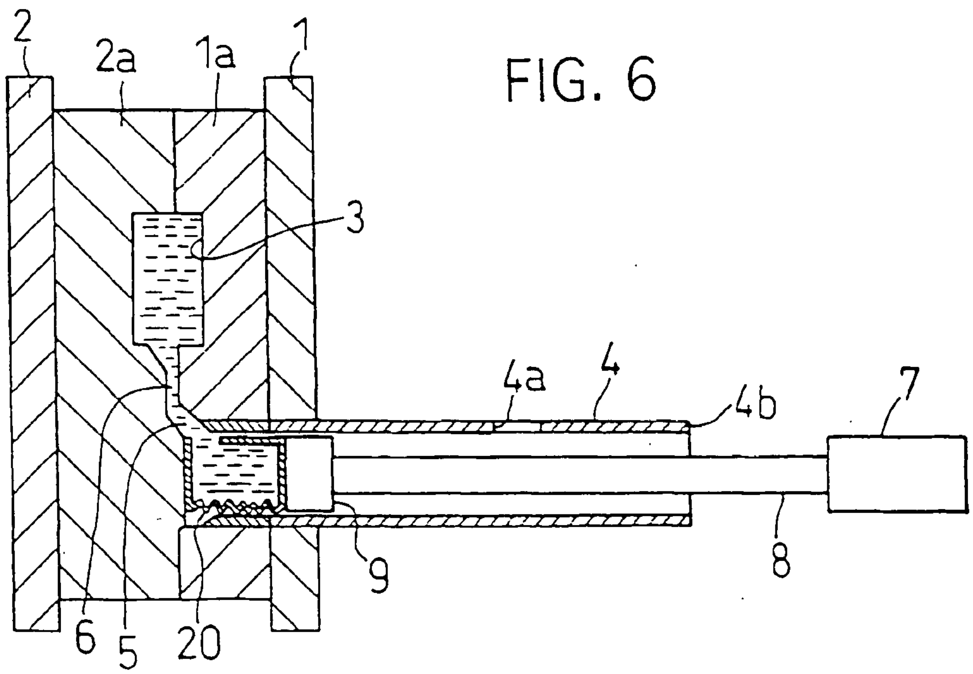
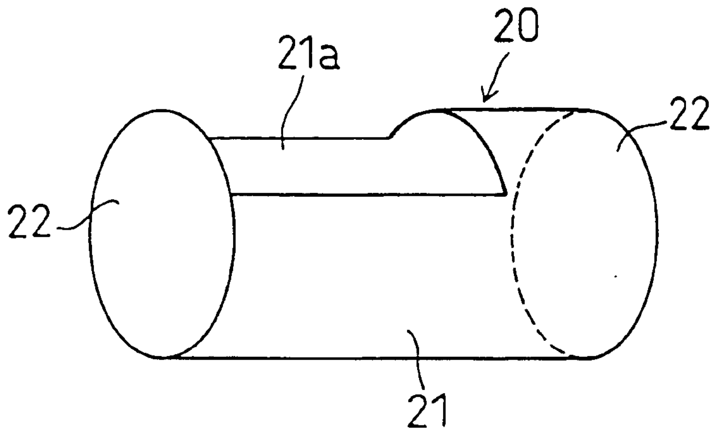


FIG. 7



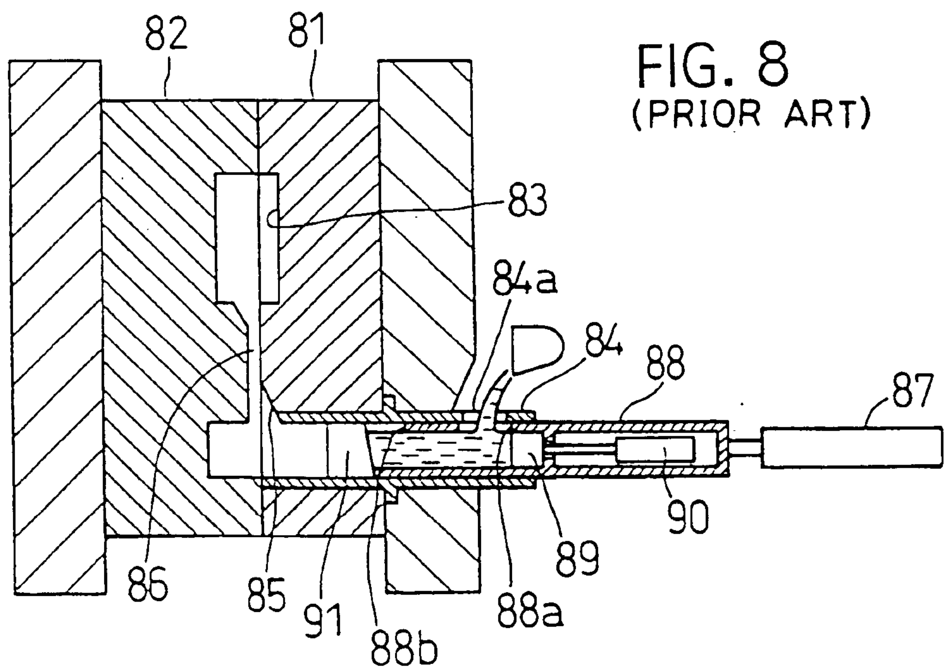


FIG. 8
(PRIOR ART)

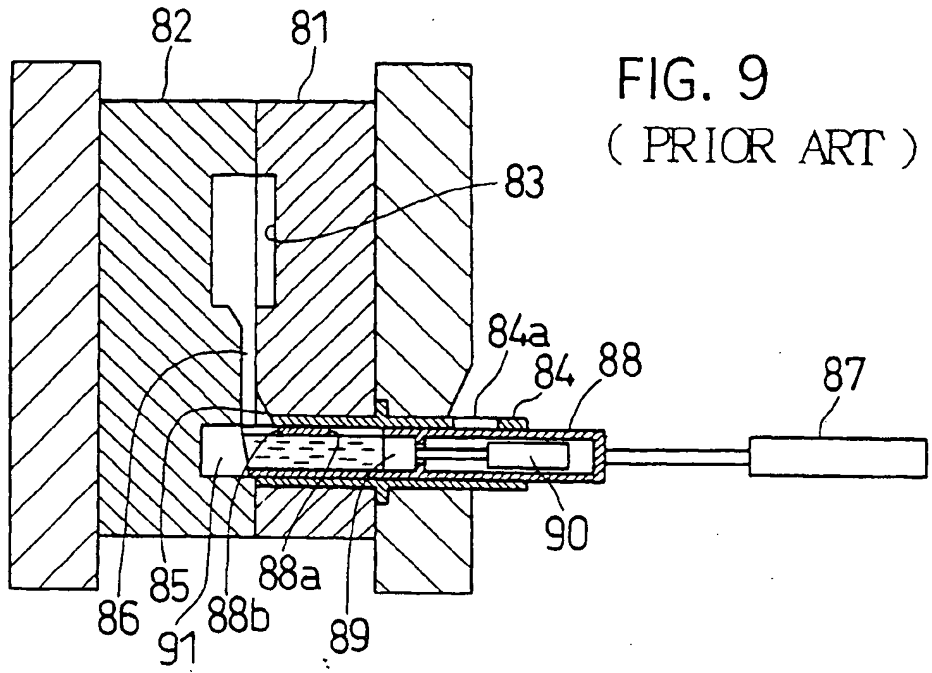


FIG. 9
(PRIOR ART)